Volume 42 JUNE, 1956 Number 6

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

This Issue

New Developments in Underground Mining Machinery

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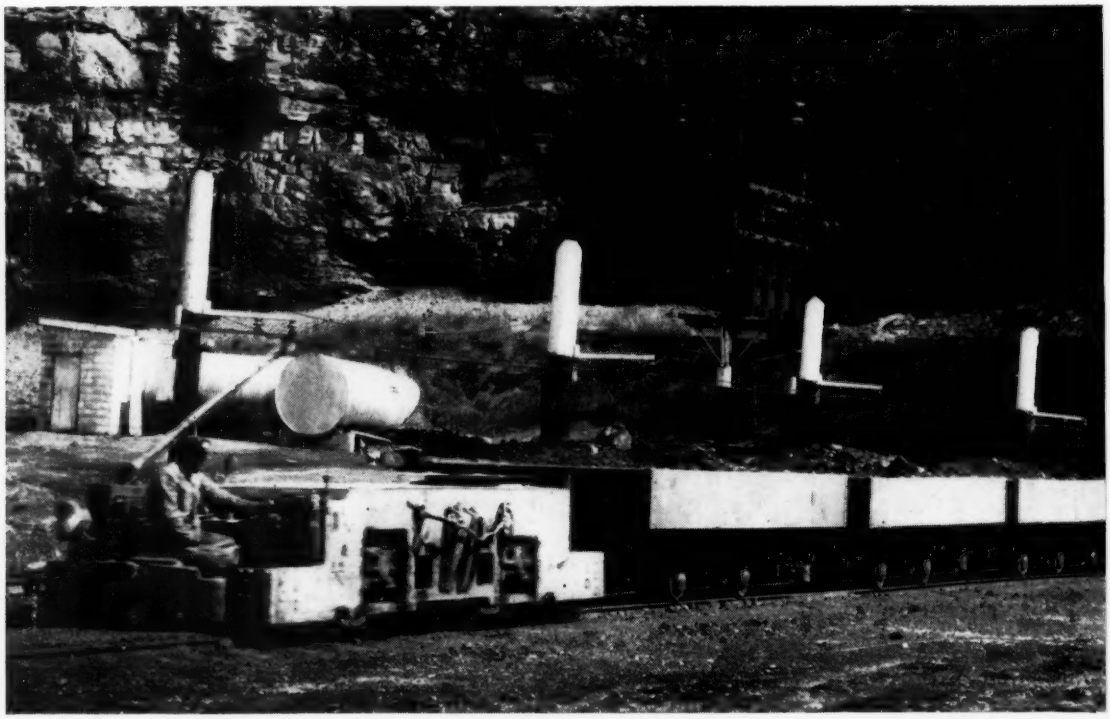

TEXACO

REG T.M.

TEXACO Lubricants

FOR THE COAL MINING INDUSTRY

LUBRICATION

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New Developments in Underground Mining Machinery

DURING recent years there has been a gradual increase in all types of mining activity. The overall high industrial output of the United States has created a great demand for minerals of all kinds, and there is great need for increased production to meet the ever expanding requirements.

The U. S. Bureau of Mines reports that in 1955 there was an increase of 11% in mineral production in the United States. The total value of $15.8 billion compared to the previous high of $14.1 billion in 1953.

Gains were registered in production of bituminous coal, copper, iron, zinc, lead, manganese, tungsten, aluminum, nickel, silenium, silver, sulfur, titanium, uranium and industrial minerals.

The great strides which have been made in underground mine production are due chiefly to new types of machines, more efficient handling of older machines and new techniques in mining and transportation.

In coal mines, the days of pick and shovel mining are about over. New mines are now 100% mechanized and only the efficient can expect to survive for any length of time. Large volume production is imperative to balance modern production costs.

The continuous miners as originally developed for mining coal were not adaptable for harder materials, but recently suitable modifications have been developed for mining potash.

Coal cutting machines, on the other hand, can be used for mining several of the softer industrial minerals.

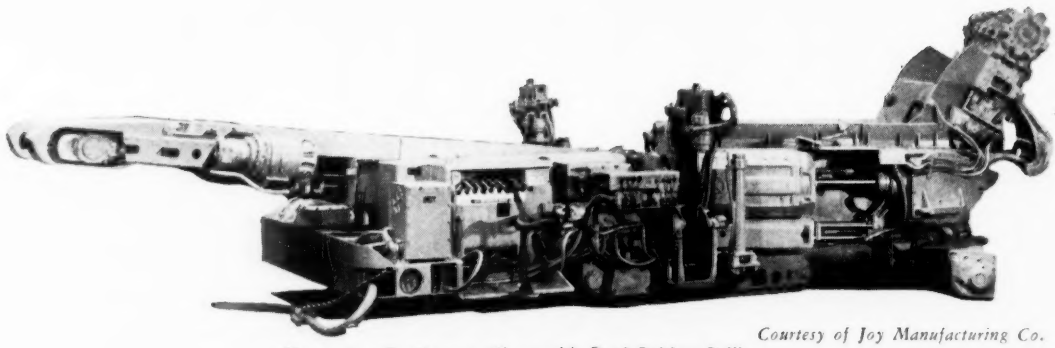
Other coal mining machinery, such as loaders, shuttle cars, conveyors and locomotives are also used in ore and industrial mineral mining.

On the other hand, there are several types of equipment used in hard rock and industrial work that are not generally used in coal mining. Examples are mucking machines, crushers, slushers, deephole drills and Diesel equipment, including locomotives, tractors, trucks and bulldozers.

POWER

Power, of course, is one of the prime requirements in mining operations. During recent years the use of power in mechanized mining has gone through some interesting transitions:

1. *Air Power* is still used in drills, pumps, hoists and other equipment, but it is being replaced in many instances by electric or hydraulic power. Air is also used in coal shooting equipment.
2. *Electric Power* is employed extensively in motors for operation of underground mining equipment such as continuous miners, cutters, loaders, shut-



Courtesy of Joy Manufacturing Co.

Figure 1 — Continuous Miner with Roof Bolting Drills.

tle cars, timber setters, car pullers, conveyors, and locomotives.

3. *Hydraulic Power* is being used wherever possible on the newer mining machines since it provides an efficient, smooth operation and greater ease in handling the machines. There is a trend towards replacing electric power with hydraulic power, especially in the manipulation mechanisms of mining equipment.
4. *Diesel Power* is being employed increasingly in non-coal mines. Diesel locomotives, tractors, trucks and bulldozers are used in many mines producing ore and industrial minerals.

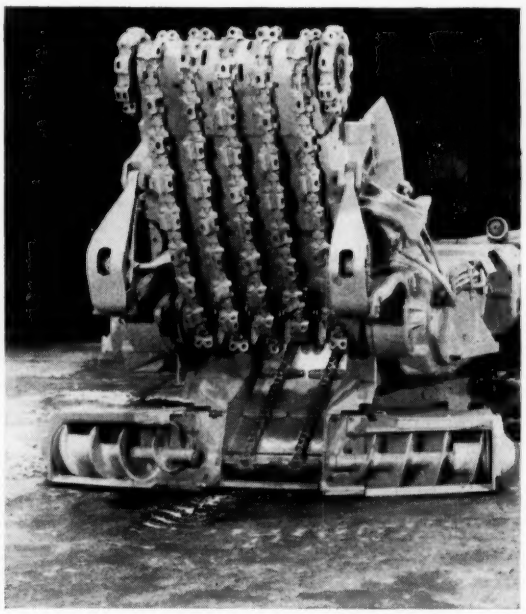
The following discussion presents a brief description of some of the more recent types of mining machinery which are in use today in underground mining.

CONTINUOUS MINERS AND BORERS

In bituminous coal mining, the continuous miners and borers speed up production in many ways. They are high capacity combination machines which take the place of other machines such as those used for cutting, drilling and loading. They also eliminate the use of explosives for blasting; this provides greater safety from the standpoint of roof stability. They cut and load coal continuously and save much time which would be required to maneuver other machines into place. These machines are capable of high production with economy and safety. One of the newer models is also equipped with roof bolting drills which facilitate securing the roof as the machine advances, without holding up production.

The miners and borers usually have rotating breaker arms or multiple chains bristling with bits which cut or break the coal from the solid face. The head of the machine can be adjusted easily to handle various seam heights, and it cleans up as it moves along.

The machines advance on tractor treads, cutting entries and rooms from 10 to 20 feet in width and three feet or more in height. Under favorable conditions 80 tons or more per man day can be produced. They are operated by means of electric and hydraulic controls from a central point on the machine about 20 feet from the face.



Courtesy of Joy Manufacturing Co.

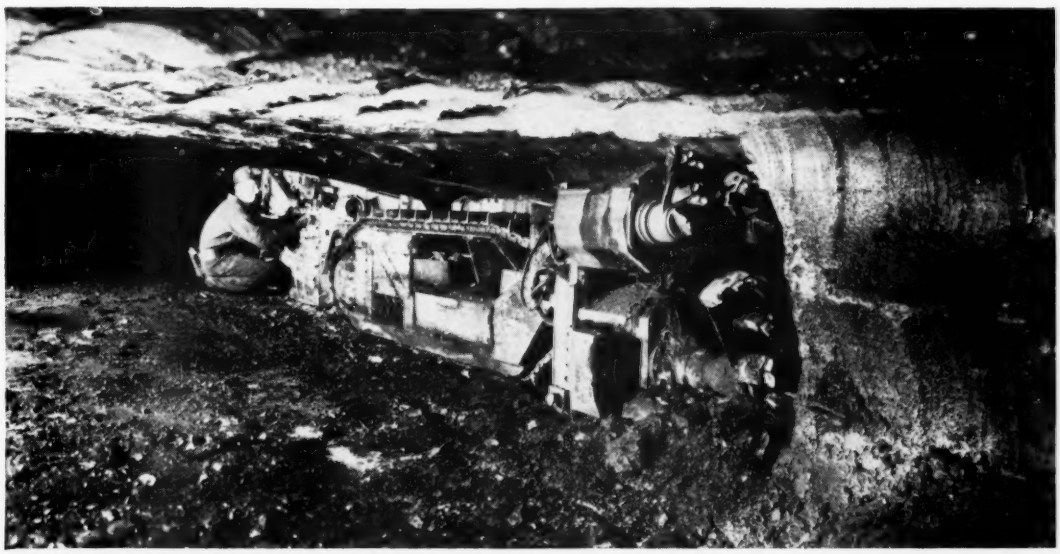
Figure 2 — Cutting End of the Continuous Miner shown in Figure 1.

The latest models of miners and borers are more powerful, more rugged and easier to maneuver than their predecessors and are required to withstand very severe and adverse operating conditions. These models are also more versatile and safer to operate.

In the past, continuous miners have been used only in bituminous coal operations, but recently special modifications of these machines have been developed for the use in potash mining. Very satisfactory performance has been obtained.

CUTTING MACHINES

Universal types of cutting machines are mounted on crawlers or pneumatic tires, or on wheels for track operation. They can be used for cutting coal, potash, salt, gypsum and soft limestone, prior to blasting.



Courtesy of Jeffrey Manufacturing Co.

Figure 3 — A Colmol Continuous Miner in Operation.

These machines are equipped with a single cutting bar which can be adjusted for making any kind of horizontal or vertical cut in the seam, ranging from one foot below the floor level to thirteen feet above. Depth of cut is approximately nine feet.

The latest models have very rugged and compact construction and can be maneuvered with speed and ease. The cutter chains are driven by a powerful electric motor for the actual cutting. The other operations such as adjusting the cutter head, operating the cable reel, tramming and steering are actuated hydraulically. Universal types can be operated from either side of the machine from identical controls.

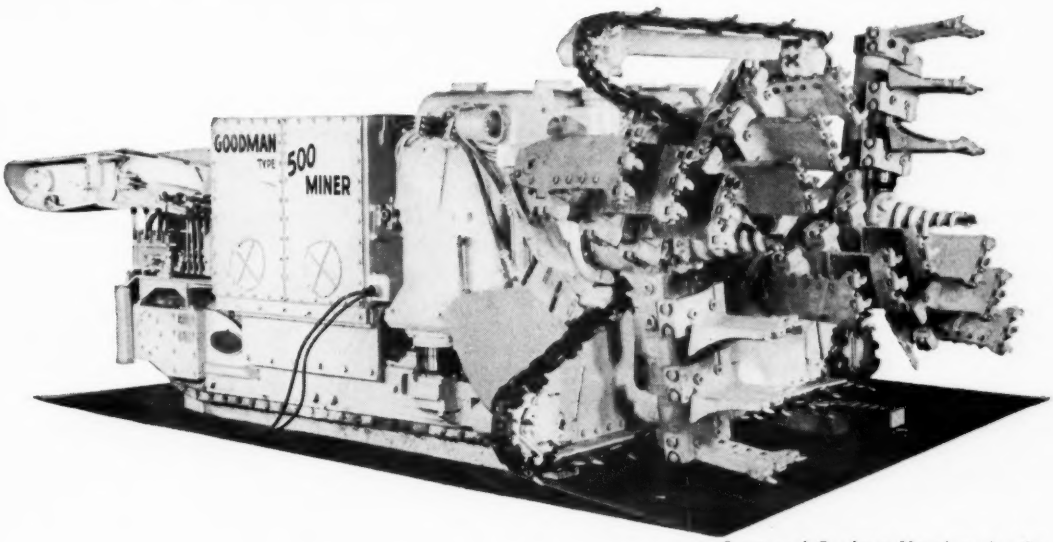
These machines are available in various heights ranging from 30 to 45 inches.

MECHANICAL LOADERS

Tractor or rubber tire mounted loaders are being used in handling not only coal but also all other types of mined materials.

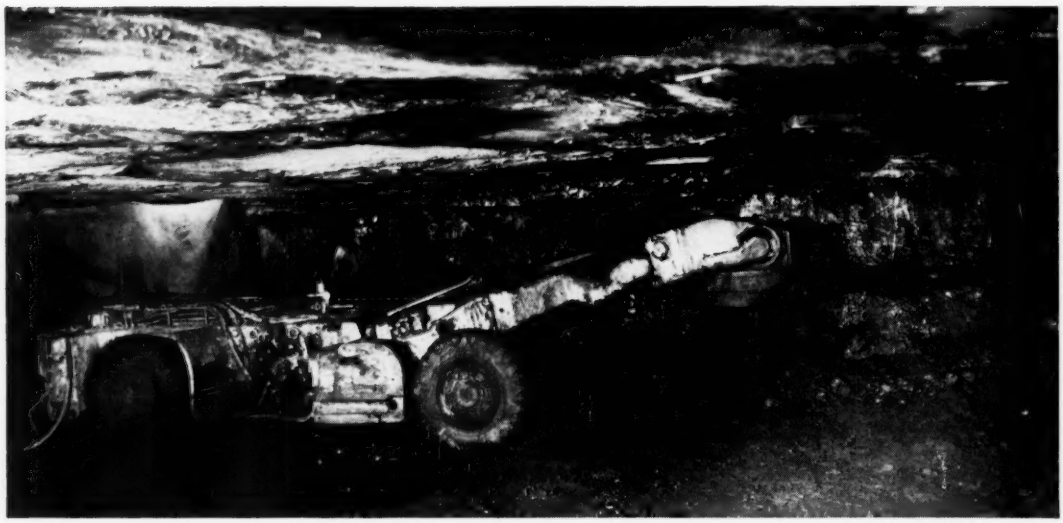
The gathering arms bring the material on to the loader which delivers it to shuttle cars or conveyors.

New models have been greatly improved in many ways:



Courtesy of Goodman Manufacturing Co.

Figure 4 — Continuous Miner.



Courtesy of Jeffrey Manufacturing Co.

Figure 5 — A Universal Coal Cutter in action.

1. Power has been increased up to 65 HP in some units.
2. Loading capacity has been increased 20% over previous models.
3. Tramming speeds have been increased up to 140 ft. per minute.
4. Conveyor speeds have been increased up to 300 ft. per minute.
5. They will withstand heavier duty, are easier to operate and will deliver greater tonnage than older models.

One type of loader is equipped with a detachable auxiliary conveyor which is fastened to the discharge boom by a pivot allowing 180 degree swing between units. The discharge end of the conveyor rides on a four wheel dolly which rides on the edge of the room conveyor. This system gives great flexibility and provides continuous flow from the face with faster delivery than stop and go transportation.

SHUTTLE CARS

The new models of shuttle cars have very rugged construction and some are equipped with four wheel drives, four wheel steering and four wheel brakes. They are built in heights ranging from 30 inches to 55 inches, and with the use of sideboards they have a capacity of from three to ten tons. When loaded they can travel from three to five miles per hour. They are operated by powerful motors and are also equipped with hydraulic systems for steering and operation of the discharge conveyors which are adjustable for discharge height.

The new models have the following improved features:

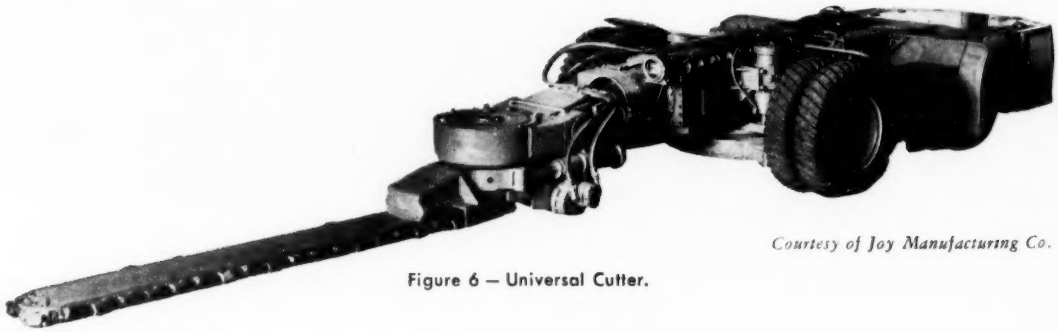
1. Carry a larger load
2. Can travel faster
3. Are easier to steer
4. Have faster rate of discharge

Most shuttle cars are powered by electricity; however, in some of the western, non-coal mines diesel electric shuttle cars are now used.

BELT CONVEYORS

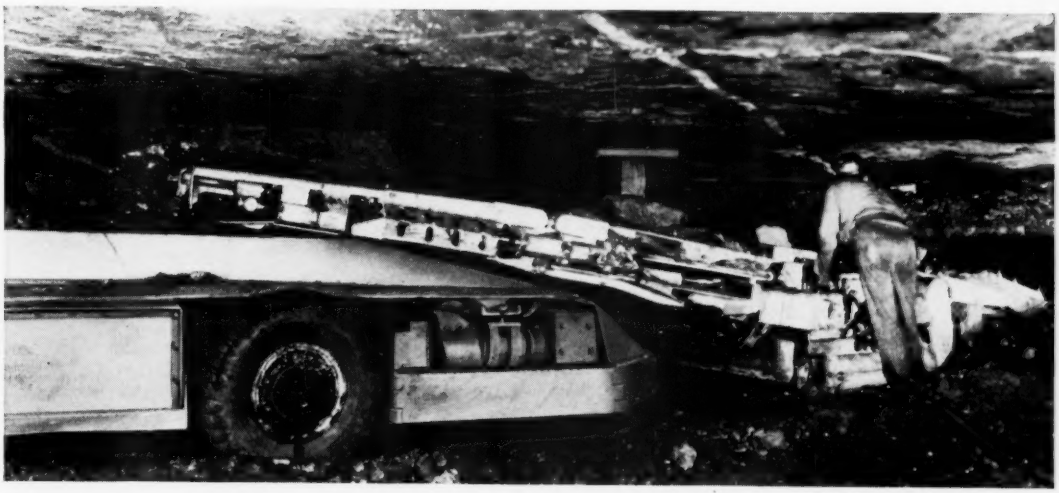
There is a definite trend toward the use of belt conveyors to remove coal or other minerals from the mine face in a continuous flow.

One new type of conveyor will extend or retract 50 feet while operating under full load. Additional 100 foot sections can be added in a few minutes,



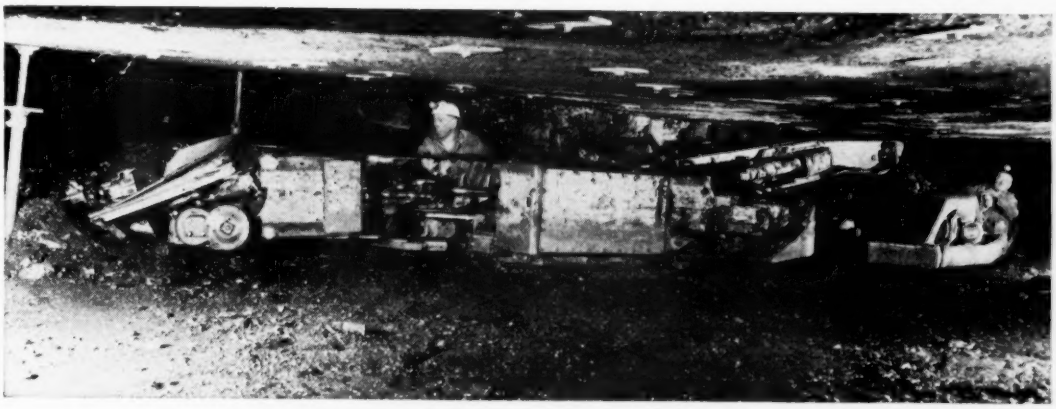
Courtesy of Joy Manufacturing Co.

Figure 6 — Universal Cutter.



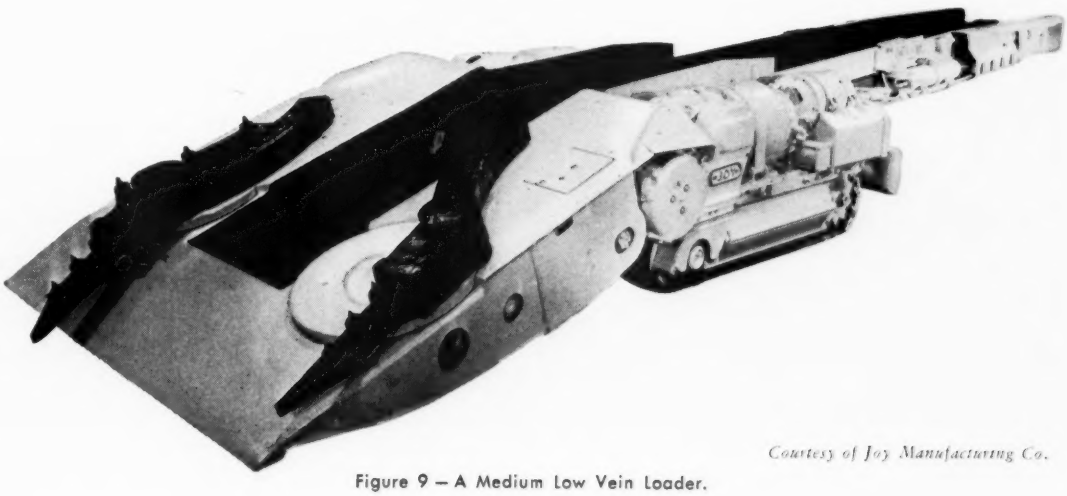
Courtesy of Jeffrey Manufacturing Co.

Figure 7 — Operating with a Crawler Loader.



Courtesy of Goodman Manufacturing Co.

Figure 8 — A Low Vein Loader.



Courtesy of Joy Manufacturing Co.

Figure 9 — A Medium Low Vein Loader.

Courtesy of Goodman Manufacturing Co.

Figure 10 — A Low Vein Shuttle Car.

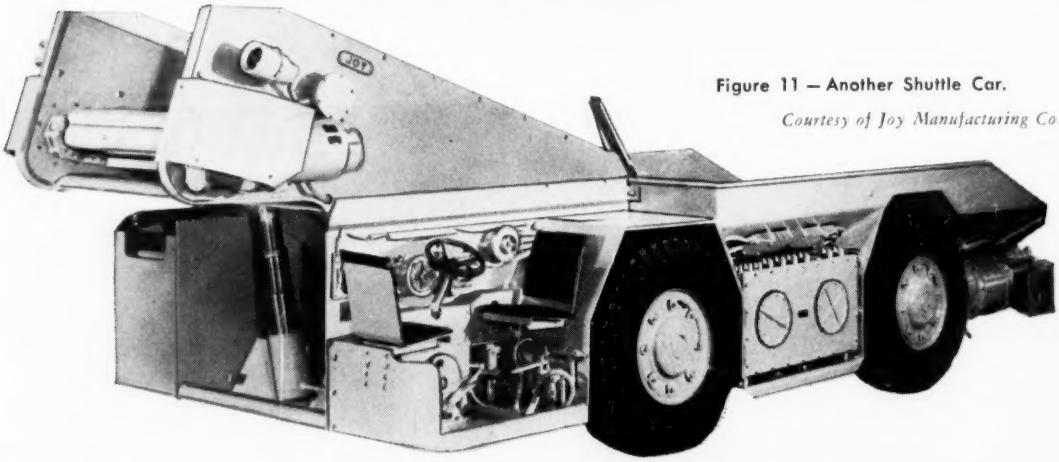
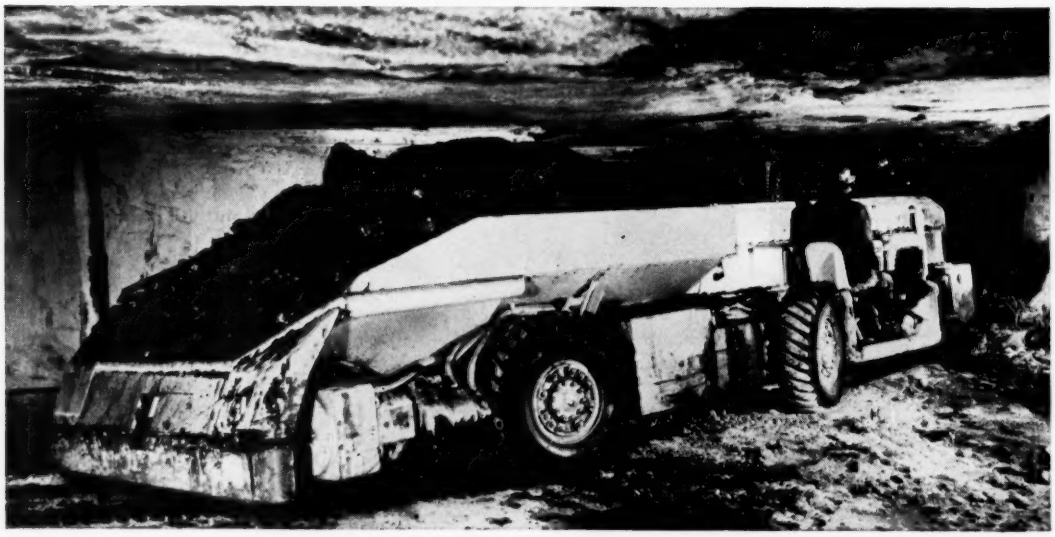


Figure 11 — Another Shuttle Car.

Courtesy of Joy Manufacturing Co.



Courtesy of Jeffrey Manufacturing Co.

Figure 12 — Still Another Shuttle Car.

Courtesy of Goodman Manufacturing Co.

Figure 13 — A Rope Belt Conveyor in operation.

and the ultimate conveyor length can be about 1000 feet. It consists of two sections — a head section which automatically deals out belt while advancing and takes it up while retreating, and a tail section to which extensions can be attached.

Both sections are mounted on hydraulically powered crawlers. Belting is available in 24 inch, 30 inch and 36 inch widths. It is equipped with flexible suspended idlers which permit the belt to assume a concave shape for carrying the load. The complete belt assembly is powered by three motors.

Another new type of conveyor is suspended from wire rope, which in turn is suspended under tension from adjustable jacks bolted to the roof. Idlers are also suspended from the wire ropes forming a concave surface to carry the load. The return belt is carried along on idlers attached to racks spaced on the floor at regular intervals. These conveyors are reported to be very easily moved from one location to another.

In some mines loading machines, shuttle cars and locomotives are being replaced by continuous mining machines and belt conveyors. In shaft mining the conveyors often feed into large bins from which the material is hoisted up the shaft.

It is reported that there are approximately 700 miles of conveyors used in coal mines alone.

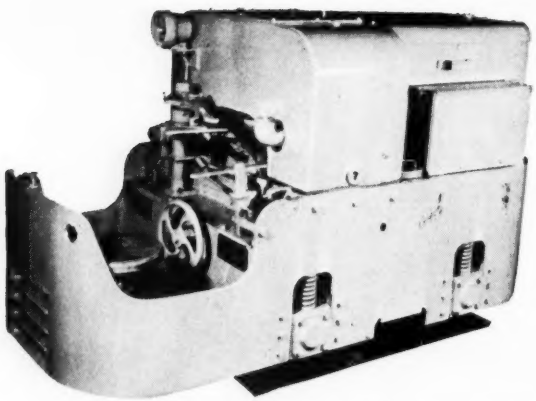
Courtesy of Goodman Manufacturing Co.

Figure 14 — Another View of the Rope Belt Conveyor shown in Figure 13.

DIESEL LOCOMOTIVES

The coal industry traditionally has used electric locomotives for haulage of cars. The use of diesel locomotives has gained little or no headway in U. S. coal mines; however, they have been used for years in European and Canadian coal mines. On the other hand diesel locomotives are used quite extensively in mines producing metallic ores and industrial minerals.

Recently, a small powerful two ton diesel locomotive has been developed for use in mines where haulage requirements do not exceed 1000 lb. draw bar pull. It is equipped with a 30 H.P. water cooled diesel with torque converter transmission. It also has an exhaust scrubber which removes unburned carbon, aldehydes and other irritants from the exhaust gases. Furthermore, it is equipped with



Courtesy of the Mancha Storage Battery Division, Goodman Manufacturing Co.

Figure 15 — A 2-ton Diesel Powered Locomotive.

roller bearing journal boxes fitted with synthetic rubber seals to keep grease in and water out.

One advantage of diesel over the electric locomotive is the elimination of overhead power lines and the necessity for track bonding.

OTHER DIESEL EQUIPMENT

There is a trend towards use of several varieties of diesel equipment in those mines where there is sufficient head room to accommodate them.

In potash mines, four-wheel tractors are used for general cleanup. Diesel powered trucks are also used for transporting supplies and tools, and diesel bulldozers have been found very satisfactory for recovering ore in old mining areas.

In lead mines diesel dump trucks and diesel electric shuttle cars are used for haulage.

Diesel powered machines are usually equipped with exhaust scrubbers to remove irritants.

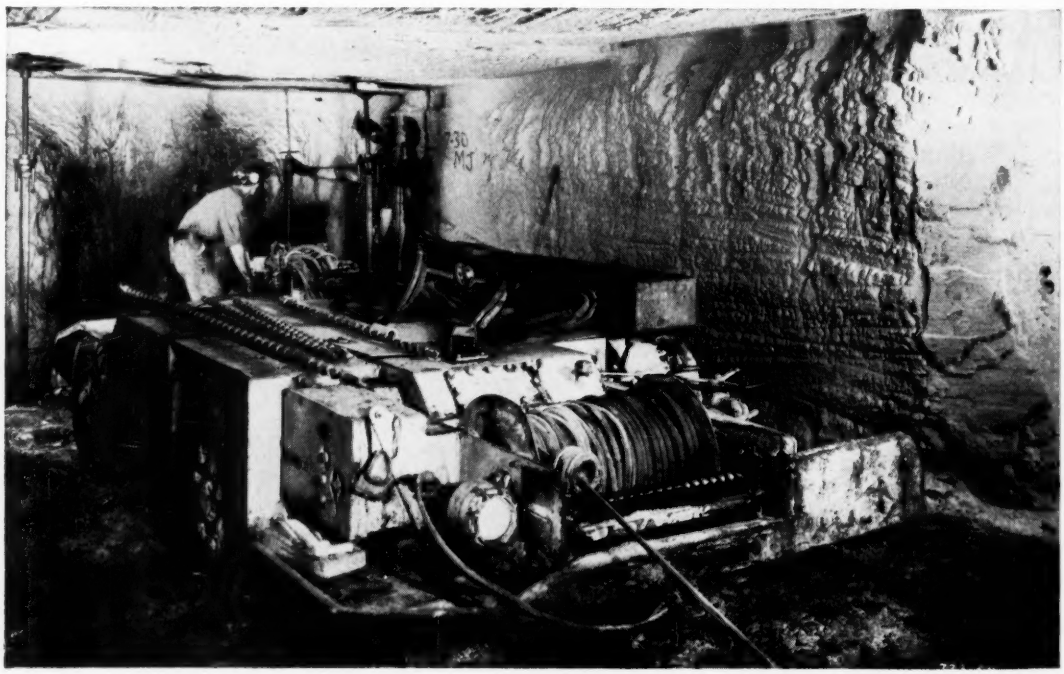
HYDRAULIC ROTARY ROOF DRILLING MACHINES

Latest types of hydraulic rotary roof drilling machines are made for track or for rubber tired truck operation. The drill boom swings horizontally and is raised vertically by hydraulic power. The drill head at the end of the boom also operates by a hydraulic motor that drives the drill and also the impact wrench. The hydraulic operation provides high pressure thrust and instant control of drill speed and torque.

The drill socket is connected to a water supply so that water can be forced through the drill rod to the bit. This prevents dust formation.

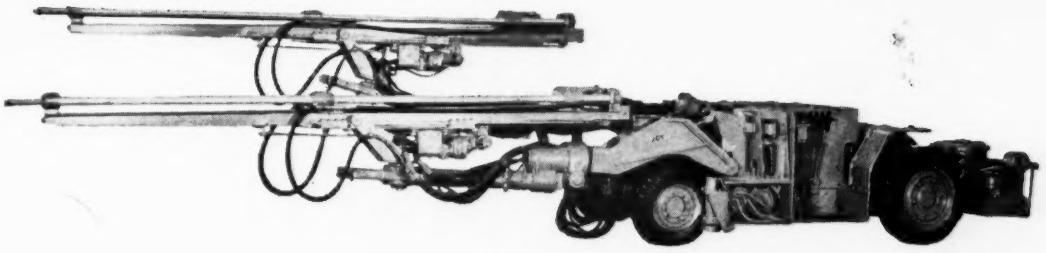
After the hole is drilled to the required depth, an impact wrench in the drill head is used to anchor and tighten bolts where expansion units are used. The machines usually range in height from 33 to 37 inches.

These machines are used for drilling holes for roof bolting in all types of mines. Rotary drilling is suitable only for certain rock formations. Some roof rock is too dense or abrasive and requires pneumatic hammer drills for penetration.



Courtesy of Jeffrey Manufacturing Co.

Figure 16 — Roof Drilling Machine.



Courtesy of Joy Manufacturing Co.

Figure 17 — Twin Boom Hydraulic Face Drill.

ROOF BOLTING

The practice of roof bolting has been adopted for virtually all types of mining operations. It is replacing the standard wooden props and gives more room for maneuvering mechanical equipment. Roof bolting continues to be the best means of reducing the number of injuries from roof falls.

Bolts for roof support may vary in diameter from ¾ to 1 inch and in length from 3 to 7 feet. They usually have a flash head and threads are rolled. A roof plate at the head of the bolt helps distribute the pressure in the surrounding area. Plates are usually 6 x 6 x ⅜ inches and made of mild steel. New type plates are cupped slightly to provide more rigidity. Wooden headers are also sometimes used in place of metal plates.

New type expansion units with heavily corrugated exterior have been developed recently. When the bolt is screwed in they expand four ways and provide a rugged socket anchor.

DEEP HOLE PERCUSSION DRILLING

For many years deep hole drilling has been practiced for purposes such as exploration, ventilation, draining old workings, and water lines for fire fighting. With the older equipment, progress was slow and a depth of 35 feet per drill shift was average.

In recent years, however, there have been many improvements, such as, better quality sectional drill rods and the use of tungsten carbide rock bits. Now the depth per drill shift has been increased 3 or 4 fold and hole sizes are larger. This results in a great increase in tonnage per man shift, lower powder cost and reduction in breakage costs.

Deep hole drilling is now used extensively in various stoping applications, pillar recovery, exploratory sampling and for driving shafts.

HYDRAULIC DRILLING

Hydraulically operated drills, because of their flexibility as to feed pressure and rotational speed, have proved to be much superior to electric drills which have fixed thrust and speed. They are used extensively for drilling coal, gypsum, potash, salt, limestone and some types of iron ore in preparation for blasting.

In some units, two drills are mounted on a self propelled chassis and can be directed at various angles. The rate of travel when drilling slowly can be set between 0 and 15 feet per minute but when retracting is desired, it can operate 80 feet per minute.

The operator handles all control valves from a centralized location for manipulating the drill assembly, the controls for steering, tramming and for drill feeding.

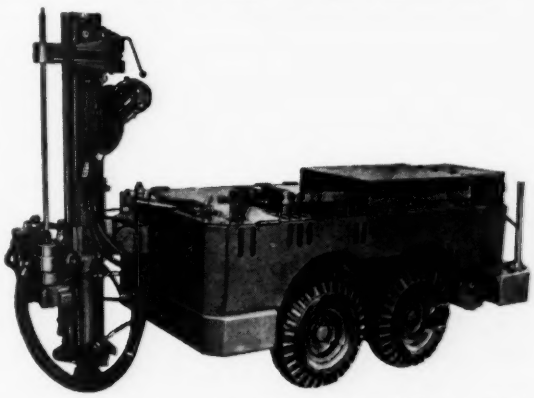
The hydraulic system is operated by a 25-30 H.P. electric motor driving hydraulic pumps.

Two operators are able to drill 175 to 300 holes per shift in bituminous coal.

MUCKING MACHINES

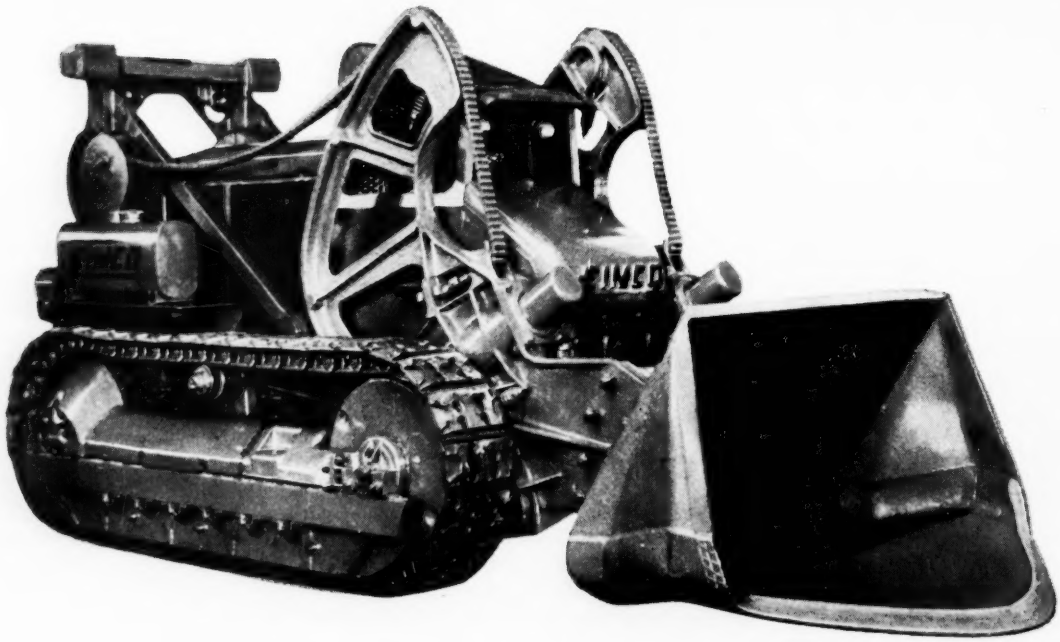
New types of tractor mounted loaders powered by air, diesel or electricity are being used in many mines. They have independent track control enabling them to make a pivoted turn. This makes it possible to attack a muck pile from any angle without backing away. Their extra-rugged construction makes them suitable for heavy duty operation. Bucket loading capacity is 2-3 tons per minute.

Air, diesel or electrically powered tractors and bulldozers are also being used quite extensively.



Courtesy of Joy Manufacturing Co.

Figure 18 — Hydraulic Rotary Roof Bolting Drill.



Courtesy of The Eimco Corporation

Figure 19 — Tractor Excavator.

SLUSHERS

"Slushers" are gaining wide use for handling ore in stopes. The newer models are now equipped with 1, 2 or 3 rope drums which can be used simultaneously. The machines are powered by electric motors ranging from 15 to 75 H.P. Construction is rugged, and gears and bearings are carefully housed to prevent contamination with dust and water.

LUBRICATION

Lubrication of mining equipment often is impaired by the adverse operating conditions which exist in most mines.

Water, often acid in nature, is always present and if it gains entrance to equipment it will cause deterioration of the lubricating properties. It will also cause rusting of parts unless the lubricant has good rust preventive characteristics.

Dust, mixed with lubricant, makes it abrasive and will cause wear of metal parts.

Heat, if excessive, may thin the lubricant causing it to leak from bearings or gear cases. It will also increase the rate of oxidation and decrease the life of the lubricant.

Mechanical mining is a heavy duty operation which imposes severe loads on gears, bearings, chains and hydraulic systems which comprise the various units.

Loads developed by manipulation and operation of these machines will react upon the lubricants, and therefore the selection and proper application of these products is most important.

Lubricant manufacturers have cooperated with mining industry to develop products that will withstand the above adverse conditions. It has often been necessary to use special additives to provide better lubrication in these heavy duty operations.

Primarily, mining machine lubricants should be carefully refined and adapted to the design of the parts on which they are to be used.

Modern mine machinery is usually equipped with centralized lubricating systems which are well protected against contamination.

There is a strong trend towards consolidating the number of lubricants and simplifying application procedures. In mines where a score of lubricants were formerly used, it has been possible to cut the number down to 3 or 4 and still provide adequate lubrication. This simplifies stocking and storage, and lessens the chance of using wrong lubricants. When the number of lubricants is reduced, it is advisable to use premium grade products that will provide trouble free lubrication. Prolonged lubricant life, better protection of equipment and reduction in consumption will more than compensate for the increased cost of high grade lubricants. Simplified lubrication plans may include the following types of lubricants:

OILS

Gear Oils (Mild EP Type)

These usually contain lead naphthenate and other EP agents. They should have good resistance to oxidation which will provide long lubricant life.

They are used for lubrication of enclosed gears on cutting machines, loader gathering-heads, shuttle cars, continuous miners and locomotives. They are also satisfactory for lubrication of bearings as well as gears where both are lubricated by the same system.

Gear Oils (Adhesive Type)

Very adhesive gear lubricants containing special additives which provide resistance to water action are required for proper lubrication of exposed gears in all types of mine equipment. These products can also be used on shaft hoists and they afford excellent protection to wire ropes especially where subjected to contact with water.

Pale Oils

Highly refined, medium viscosity pale filtered oils should be capable of providing good lubrication over a wide range of temperature conditions.

They are used for lubrication of plain bearings and miscellaneous parts on sprockets and chains, shaft hoists, crushers, mine fans, waste packed motor bearings, cutting machines, loaders, shuttle cars, continuous miners and locomotives.

Cylinder Oils

Well refined steam cylinder oils compounded with animal fats are required in steam engine cylinders, especially where wet steam conditions exist.

Turbine Oils (Inhibited)

Premium grade turbine type oils containing rust and oxidation inhibitors have many uses in mining equipment. The additives provide long oil life and protection against rusting of machine parts.

They are used in steam turbine circulating systems and in hydraulic systems on cutting machines, loaders, shuttle cars, continuous miners, and locomotives.

Rock Drill Lubricants (EP Type)

These specially compounded lubricants are used in rock drills, hammer stopers and air driven mine pumps. They atomize readily insuring distribution of oil to all parts. Their adhesiveness and EP properties protect drills against wear under severe load, and their rust preventive ability protects machines when operating under adverse moisture conditions.

Transformer Oils

These highly refined oils must have high dielectric strength, good oxidation stability and very low pour test.

They are required for use in transformers, electric switches and circuit breakers.

High Film Strength Oils

These products should have detergent and dispersion properties to keep fuel soot, sludge and dirt in suspension when used for lubrication of diesel and dual-fuel engines.

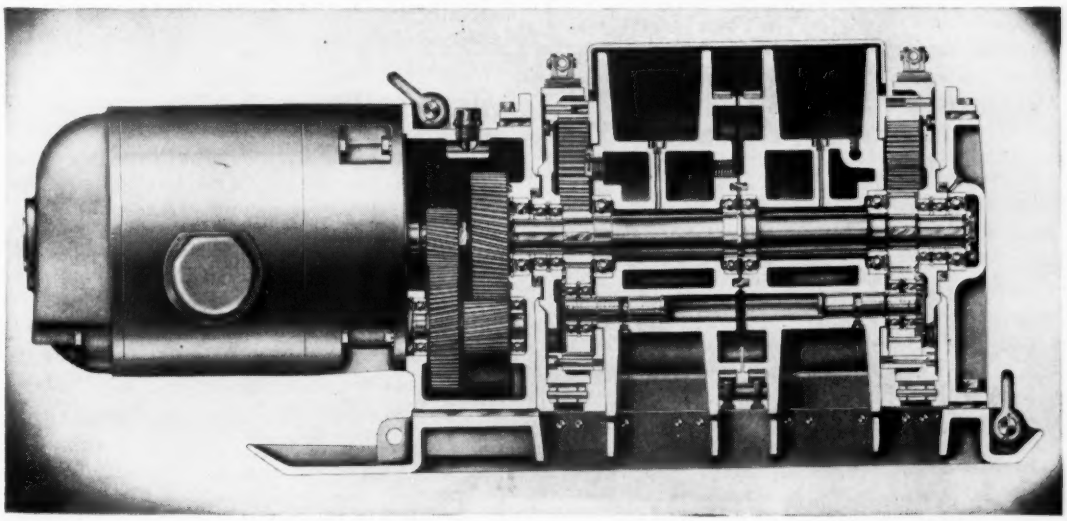
They can also be used on friction clutches on cutting machines, loaders, shuttle cars and continuous miners.

GREASES

Soda Base Type

This grease should form a tough durable film under severe load conditions. It should also be very adhesive and cohesive so that it will resist leakage.

It is recommended for use in enclosed gears in non oil tight cases on cutting machines and other mining equipment.



Courtesy of Joy Manufacturing Co.

Figure 20 – Cutaway View of a Slusher.

Semi fluid grades are used in gathering head gear cases, pressure fittings on loaders, wheel units on shuttle cars and continuous miners, mine car cavity type wheel bearings.

Lithium Base Type

This type of grease should have a high dropping point and be suitable for operation at high temperatures. It should give good service under adverse conditions such as contamination with water and dust, also when subjected to high heat or to low atmospheric temperatures.

It is recommended for lubrication of ball, roller, and plain bearings on mine ventilating fans, motor generators, electric motors, shaft hoists, cutting machines, loaders, shuttle cars, locomotives, control mechanisms and mine pumps.

Soda-Calcium Base Type

This type of grease has medium high dropping point and is suitable for lubrication of the same type of equipment as Lithium Base grease but where lower operating temperatures prevail.

Calcium Base Type

This grease is resistant to action of water and should contain a high viscosity oil which will insure an adequate lubricating film under heavy loads, low speeds and low temperature.

It is used extensively for lubrication of mine car wheel bearings, locomotive wheel bearings, plain bearings of shaft hoists, chassis of diesel trucks and tractors and other mining equipment.

Wool Yarn Elastic Type

This type grease is a combination of wool yarn impregnated with a semi fluid grease. It should be suitable for low temperature operation.

It is recommended for open type waste packed bearings on motors and hoist equipment.

STORAGE AND HANDLING OF MINING LUBRICANTS

The mining industry is always faced with the problem of preventing waste of lubricants. Lubrication cost is a large item in mine operation but it is highly desirable to protect expensive mechanical equipment by proper lubrication.

Great care should be taken in handling lubricating oils and greases to prevent contamination. Often oil and grease drums are found exposed to the weather with bungs out and lids off allowing contamination with water and dirt.

Central Storage House

To store and handle mine lubricants properly it is highly desirable to have a centrally located oil and grease house, preferably of fire proof construction. It should be kept clean and orderly at all times. It is also advisable to have one individual responsible for storage, handling and distribution of all lubricants.

Outside Storage

If drums are to be stored outside, precaution should be taken to see that the oil drums are placed on racks on their sides and equipped with faucets and drip pans. This will prevent water seeping into the oil and permits easy oil removal.

If drums are stored outside in an upright position, they should be set at a slight angle so that water will drain away from the bung in the top. This will minimize any leakage of water into the drums.

Underground Storage

Handling and storage of lubricants inside a mine will present problems dependent on the height of seam and the extent and type of mechanization.

State safety laws also regulate the amount of lubricant that can be stored in a section. Each mine presents an individual problem.

DISPENSING EQUIPMENT

Great care should be taken with containers for dispensing lubricants to make sure that greases and oils are not mixed in the equipment or in bearings or gear cases. A clean paddle or a suitable pump should be used in transferring grease from drums to smaller containers used by miners.

Methods of Distribution

1. *Mine Oil Car Haulage*
   Oils from bulk storage or in drums can be loaded on oil cars and hauled to each section where they can be piped by gravity into partially buried 55 gallon storage tanks. From these tanks the oiler can fill his 5-gallon cans to distribute the oils to the machines.
2. *Mine Car Haulage*
   Drums of oil can be carried on mine cars into any section and oil can be dispensed into 5-gallon cans for delivery to the equipment. Drums of grease can be taken to the section where dispensing equipment can be installed to deliver grease directly to the machines.
3. *Conveyor Haulage*
   In those mines equipped with belt conveyor systems, 5-gallon cans of oil and pressure guns filled with grease can be sent to the face on belts for direct application to machines.

In conclusion, the main goal in the proper storage and handling of mine lubricants is to provide "cleanliness"; keeping lubricants clean and free of contamination will give them the chance to do the work for which they were intended.

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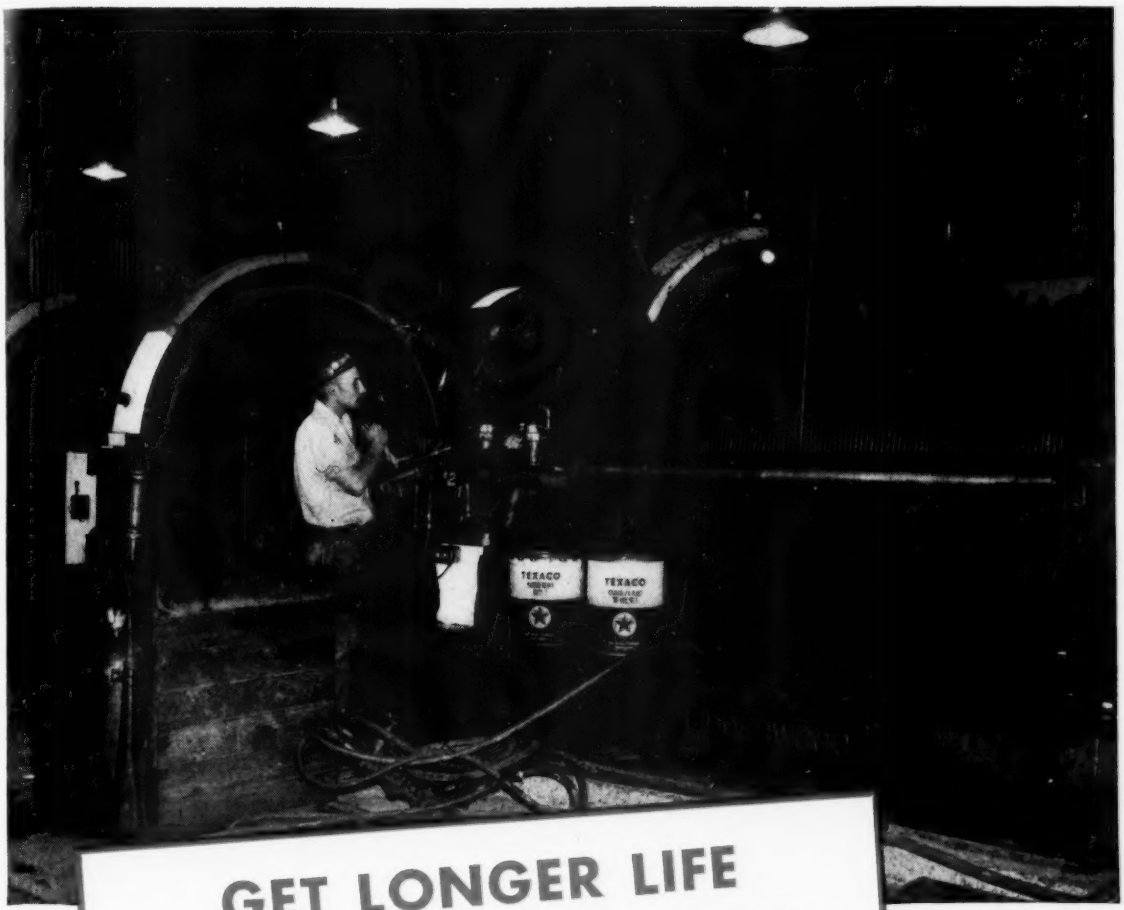

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